

SURVEY MEASUREMENT OF HETEROGENEOUS PROBABILISTIC EXPECTATIONS

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1. Introduction

Micro data are often useful to formulate and evaluate economic policy. They are particularly vital when the heterogeneity of economic actors is a central determinant of policy outcomes. I consider here collection of micro data to measure the heterogeneous expectations that persons may hold for uncertain future events.

Economists commonly suppose that persons conceptualize uncertainty in probabilistic form. There often are good reasons to think that probabilistic expectations vary across persons. Persons may have different knowledge of the current state of the economy. Moreover, persons may have different beliefs about how the economy functions.

One might anticipate that economists would use survey questionnaires to amass micro data on the expectations that persons hold. However, empirical economic research measuring expectations was rare until recently. A broad reason is that economists have historically been skeptical of subjective statements. Indeed, students are often taught that a good economist believes only what people do, not what they say. For a considerable period, this perspective inhibited collection of micro data on expectations.

Lacking direct measures of expectations, economists have often attempted to infer expectations by combining available data with assumptions about processes of expectations formation. This is a daunting task. To infer expectations, economists must speculate about what information persons possess and how they use the available information to form their expectations.

Consider, for example, the matter of income expectations. Economists studying consumption and saving behavior often assume that persons use knowledge of their own past incomes to forecast their future incomes. Perhaps so, but how do persons form expectations of future income conditional on past income? Economists often assume that persons have *rational expectations*; that is, they know the actual stochastic process generating their income streams. Perhaps so, but what is this stochastic process? The practice has been to specify the income process up to some parameters and use available data on income realizations to estimate the parameters. Researchers differ, however, in their specifications. So the literature displays competing models of expectations formation, with no clear way of distinguishing among them.

Over the past quarter century, the historical inhibition of economists to collect micro data on expectations has largely dissipated, generating a substantial body of empirical evidence on the probabilistic expectations of broad populations. Surveys eliciting probabilistic expectations are now performed regularly in many countries. Subjects that have drawn particular attention include expectations of macroeconomic events (e.g., stock market returns), risks that a person faces (e.g., job loss, crime victimization, mortality), future personal income (including the earnings returns to schooling and pensions), and choices that persons make (e.g., durable purchases and voting choices). The review article of Manski (2004) describes the emergence of this field of empirical research and summarizes a range of applications. Articles by Hurd (2009) and Delavande respectively review research using expectations data collected from older persons and from populations in developing countries.

Probabilistic expectations data are also regularly collected from panels of professional macroeconomic forecasters. Here the subjects are expectations of future GDP growth, inflation, and other aggregate economic statistics. Engelberg, Manski, and William (2009, 2011) analyze data on the probabilistic expectations of members of the American Survey of Professional Forecasters.

To illustrate the value of micro data on probabilistic expectations, I summarize below my research on two subjects that may be relevant to IMF concerns. I begin with work measuring the probabilistic expectations of equity returns held by broad populations of persons. I then turn to studies of the probabilistic expectations of professional macroeconomic forecasters. I conclude with brief remarks on measurement of expectations that do not take probabilistic form.

2. Probabilistic Expectations of Equity Returns

Expectations of equity returns are widely thought to be central determinants of investment in equities and other assets. In the absence of data on expectations, there long was disagreement about the extent and nature of heterogeneity in beliefs about returns.

Much of the finance literature has regarded heterogeneity in beliefs as either non-existent or unimportant. The original formulation of the capital asset price model assumed that all persons hold the same expectations for asset returns (Sharpe, 1964, Lintner, 1965) and subsequent discussions asserted that heterogeneity would not affect the basic conclusions of that model (Lintner, 1969, Sharpe, 1970). Adherents of the *efficient markets hypothesis* have contended that prices reveal all privately held information and concluded that expectations must be homogeneous ex post, even if they are heterogeneous ex ante (Fama, 1970).

Other researchers have argued that heterogeneity in expectations is critical to the functioning of asset markets. Early examples include Keynes (1937) and Williams (1938). Subsequent ones include Miller (1977), Mayshar (1983), Harris and Raviv (1993), Kandel and Pearson (1995), and Morris (1995). These researchers reject the core tenet of the efficient market hypothesis that persons begin with common prior beliefs and develop heterogeneous beliefs only because they receive private signals. Instead, they stress that persons may hold divergent opinions even when all information is public, the reason being that they process this information differently. Heterogeneity in the processing of information has also been a central theme of research in behavioral finance; Daniel, Hirshleifer, and Teoh (2002) review this literature.

To provide an empirical basis for study of expectations, Jeff Dominitz and I initiated survey research measuring in probabilistic terms the beliefs that Americans hold about equity returns in the year ahead. We originally posed a series of questions on our Survey of Economic Expectations (SEE) in July 1999–March 2001 and later placed one of these on the Michigan Survey of Consumers from June 2002 through August 2004. The question posed in both surveys asks respondents to state the percent chance that a diversified mutual fund will have a positive nominal return in the year ahead. The wording in the Michigan survey was as follows:

Positive Nominal Return (PNR): The next question is about investing in the stock market. Please think about the type of mutual fund known as a diversified stock fund. This type of mutual fund holds stock in many different companies engaged in a wide variety of business activities. Suppose that tomorrow someone were to invest one thousand dollars in such a mutual fund. Please think about how much money this investment would be worth one year from now. What do you think is the percent chance that this one thousand dollar investment will increase in value in the year ahead, so that it is worth more than one thousand dollars one year from now?

The SEE instrument posed this question within a sequence of questions asking for the percent chance that the mutual fund will increase or decrease in value by specified amounts. Questions similar to those fielded in SEE and the Michigan survey have also appeared since 2002 in the bi-annual administration of the Health and Retirement Study (HRS).

Dominitz and Manski (2003, 2004, 2007, 2011) described the responses and initiated research aiming to interpret the measured expectations. We found that expectations of a positive nominal equity return vary substantially across persons and systematically with sex, age, and schooling. We found that the patterns of variation are similar within the Michigan, SEE, and HRS samples. We also reported that individual beliefs exhibit considerable stability over time. The latter finding emerged from the longitudinal feature of the Michigan survey, which provides two interviews for most respondents, spaced six months apart.

Taken together, these descriptive findings suggest that individuals use interpersonally variable but intrapersonally stable processes to form their expectations. We therefore proposed in Dominitz and Manski (2011) that it is reasonable to think of the population as a mixture of *expectations types*, each forming expectations in a stable but different way. We presented an exploratory analysis that uses the Michigan and SEE data to learn about the prevalence of different types, focusing on three types that are suggested by thinking in orthodox and behavioral finance. One is a *random-walk (RW) type*, who believes that equity returns are independent and identically distributed over time and who, given this belief, uses the long-run historical record of returns to predict future returns. Another is a *persistence (P) type*, who believes that recent stock market performance will persist into the near future. The third is a *mean-reversion (MR) type*, who believes that recent stock market performance will be reversed in the near future.

If one examines the central tendency of the expectations data, one obtains the impression that the population believes in some form of persistence. However, the central tendency of expectations does not tell nearly the full story. Our main conclusion was that expectations of equity returns are very heterogeneous. Using an ordinal criterion to classify types, we find that the fractions of Michigan respondents who express expectations consistent with the RW, P, and MR types are 0.27, 0.41, and 0.32 respectively. Thus, persistence was the most prevalent type but characterized less than half of all respondents.

Further research of this type, in part building on our work, has been performed by others as well. Instances include Kezdi and Willis (2008), Hurd (2009), Hurd, van Rooij, and Winter (2011), Hudomiet, Kezdi, and Willis (2011), and Gouret and Hollard (2011).

3. The Probabilistic Expectations of Professional Macroeconomic Forecasters

Professional forecasters regularly give point predictions of uncertain future events. Financial analysts offer point predictions of the profit that firms will earn in the quarter ahead. Macroeconomic forecasters give point predictions of GDP growth and inflation. The appropriate interpretation of point predictions depends on what forecasters actually believe and what they choose to communicate. Point predictions cannot reveal anything about the uncertainty that forecasters perceive. They at most convey some notion of the central tendency of beliefs.

Point predictions should somehow be related to the probabilistic expectations that forecasters hold. But how? Forecasters may report the means of their probability distributions for uncertain events—their best point predictions under square loss. Or they may report medians—best point predictions under absolute loss. However, forecasters typically are not asked to report means or medians. They are simply asked to "predict"

or "forecast" the outcome. In the absence of explicit guidance, forecasters may report different distributional features as their point predictions. Some may report means, while others report medians or modes. Still others, applying asymmetric loss functions, may report non-central quantiles of their probability distributions.

Heterogeneous reporting practices can be consequential for the interpretation of point predictions. Forecasters who hold identical probabilistic beliefs may provide different point predictions, and forecasters with dissimilar beliefs may provide identical point predictions. If so, comparison of point predictions across forecasters is problematic. Variation in predictions need not imply disagreement among forecasters, and homogeneity in predictions need not imply agreement.

To shed empirical light on the reporting practices of professional forecasters, Engelberg, Manski, and Williams (2009) used data from the Survey of Professional Forecasters (SPF) to compare point predictions of gross domestic product (GDP) growth and inflation with the subjective probability distributions held by forecasters. We found that the deviations between point predictions and the central tendencies of forecasters' subjective distributions tend to be asymmetric, with SPF forecasters tending to report point predictions that give a more favorable view of the economy than do their subjective means/medians/modes. Citing this finding, plus the inescapable fact that point predictions reveal nothing about the uncertainty that forecasters feel, we concluded that organizations commissioning forecasts should not ask for point predictions. Instead, they should elicit probabilistic expectations and derive measures of central tendency and uncertainty.

In subsequent research, Engelberg, Manski, and Williams (2011) showed the value of probabilistic expectations data when one seeks to characterize the temporal variation of macroeconomic forecasts. It has been common to aggregate the point predictions reported by SPF panel members at each administration of the survey and analyze the time series of the aggregated predictions. Summary reports of survey findings traditionally take this form.

We observed that interpretation of the temporal variation in aggregated predictions can be problematic for multiple reasons. First, aggregated predictions reveal nothing about the uncertainty that forecasters perceive. Second, they reveal nothing about possible disagreement across the panel of forecasters. Third, aggregated predictions ignore the fact that the composition of panels of forecasters often change substantially over time. Examining the data on inflation expectations obtained by the SPF in the period 1992–2006, we concluded that the interpretative problem is always serious in principle and is often serious in practice.

To replace analysis of aggregated predictions, we recommended study of the time series of the probabilistic forecasts made by individual forecasters. Considering each forecaster separately, one may compute parameters that measure the central tendency and spread of elicited subjective probability distributions; we suggested use of the subjective median and interquartile range. This done, a plot showing the subjective (median, IQR) of each forecaster clearly portrays the heterogeneity of forecasts at a point in time. To describe the evolution of expectations across the quarterly administrations of the survey, we recommended enhancing the plot with arrows to indicate how each forecaster changes his beliefs from one quarter to the next.

Two figures from our article, reproduced here, illustrate. The top figure displays the subjective medians and IQRs for 2001 GDP growth elicited from forecasters who participated in the SPF in both 3Q2001 and 4Q2001. Thus, the figure shows GDP growth expectations before and after the terrorist attacks of September 11, 2001. Each forecaster is depicted by an arrow whose tail is his 3Q2001 prediction and whose tip is his 4Q2001 prediction. The figure shows that nearly all forecasters revised their subjective medians downward between 3Q2001 and 4Q2001. However, forecasters varied in the direction of revisions to their subjective

IQRs, with some becoming more certain about output growth and others becoming less certain.

The bottom figure displays the subjective medians and IQRs for 2006 inflation elicited from forecasters who participated in the SPF in both 3Q2005 and 4Q2005. Thus, the figure shows inflation expectations before and after Ben Bernanke's nomination to be Chair of the Board of Governors of the Federal Reserve System on October 24, 2005. The figure shows that most forecasters revised their subjective medians upwards but they varied considerably in the magnitude of the revision. Revisions to subjective IQRs were very heterogeneous in both direction and magnitude.

We recommended that the Philadelphia Fed include such plots in the quarterly summaries of SPF findings reported to the public. The plots show, in a transparent manner, an informationally rich summary of the quarter-to-quarter revisions to the predictions made by the panel of forecasters.

4. Do People Really Think Probabilistically?

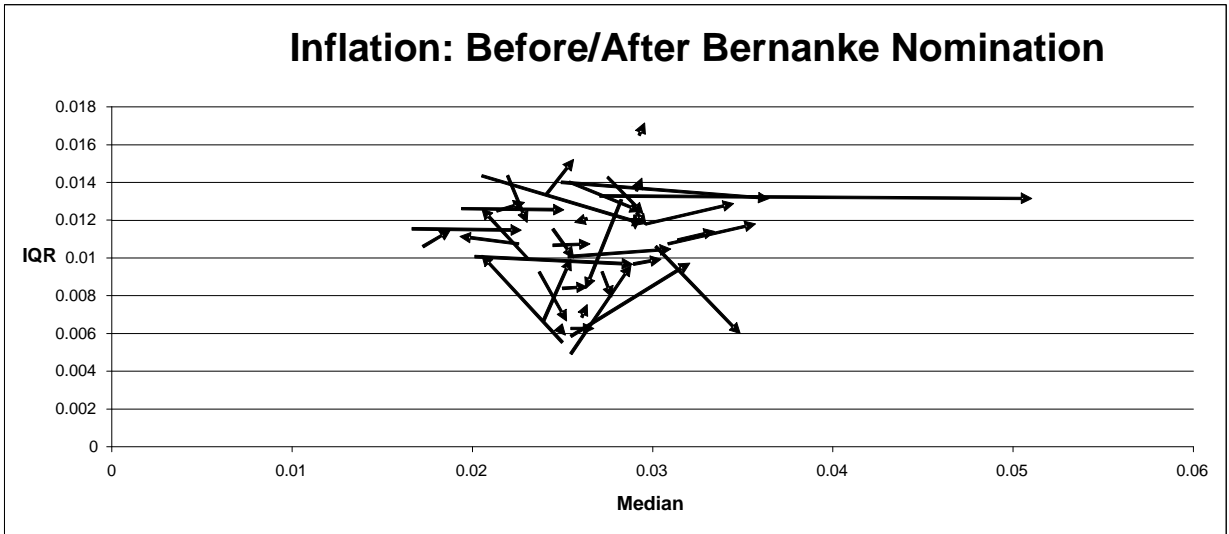
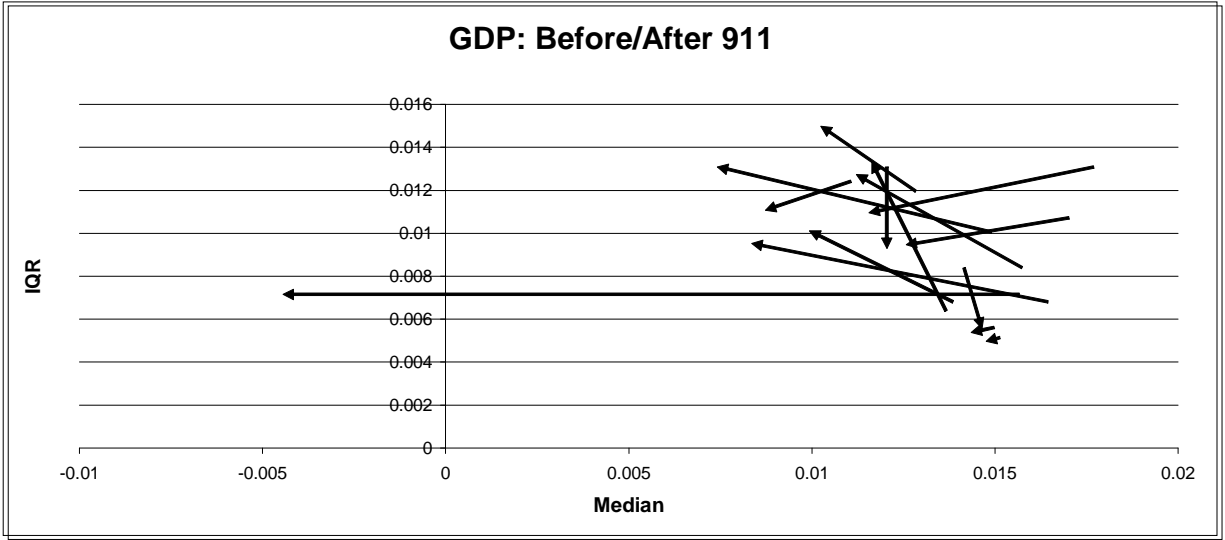
There is by now extensive empirical evidence that survey respondents are willing and able to report expectations in probabilistic form. This does not, however, imply that persons actually think probabilistically and use subjective probability distributions to make decisions. After all, survey respondents also respond to questions seeking point predictions of uncertain events or verbal assessments of likelihood. Yet persons need not use point predictions or verbal assessments of likelihood to make decisions. What the empirical evidence does show is that, however they think and act, people are willing and able to report their beliefs in multiple forms—as point predictions, verbal assessments of likelihood, or probabilistic expectations.

Among economists and decision theorists, perhaps the most compelling alternatives to the hypothesis of probabilistic expectations have been put forward in research on decisions under *ambiguity*, also known as *Knightian uncertainty*. Studies of ambiguity maintain that beliefs have some but not all the structure of a probability distribution. A particularly common idea has been that a person may hold a set of subjective distributions for an unknown event, not a single distribution.

Suppose that beliefs actually do take the form of sets of subjective distributions. Then the single distributions that we now elicit from survey respondents are probabilistic summaries of ambiguity, much as point predictions are deterministic summaries of uncertainty. To enable persons to express ambiguity, survey researchers could elicit ranges of probabilities rather than precise probabilities for events of interest. This is straightforward in the case of binary events, for which one can pose questions such as

What do think is the percent chance that event A will occur? Please respond with a particular value or a range of values, as you see fit.

This format enables respondents to express whatever uncertainty or ambiguity they may feel. A respondent can express complete ignorance by reporting “0 to 100 percent,” bounded ambiguity by reporting “30 to 70 percent,” uncertainty by reporting “60 percent,” or certainty by reporting “100 percent.” Manski and Molinari (2010) report exploratory research on responses to questions of this type. Much more is needed.



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